

ARTIFICIAL INTELLIGENCE BASED GREEN MANUFACTURABILITY QUANTIFICATION OF A UNIT PRODUCTION PROCESS

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ABSTRACT

Environmental awareness and sustainability among consumer is increasing since past decade. These consumer activity forces the industry to maintain the environment, and it began to trouble them to balance the monetary and economy against the social and environment factors while manufacturing. Thus, researchers are encouraged to develop new techniques to tackle these issues. The suggested technique should optimally maintain the environments issue and provide reasonable profit. Hence in this work, it aims to motivate unit manufacturing process to boost green manufacturing by effectively minimizing the resource. Surface grinding is one of the real time experimentations conducted in most of the industries. By penetrating greenness in the surface grinding, the environment hazard can effectively reduce. Thus in this paper, the unit process is used in the surface grinding, to effectively use the lubricant. An artificial intelligent optimization technique is proposed to control the various factors, which influence the greenness of the unit process in surface grinding. In the proposed system, the artificial bee colony algorithm is proposed, and is evaluated using numerical simulation and the performance is analysed to calculate the green index.

KEYWORDS: Unit Production Process, Surface Grinding, Greenness, Green Manufacturing & Artificial Bee Colony

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INTRODUCTION

In this day and age, organizations from different fields are managing ecological commitments [1]. In the previous couple of decades' un-went before development in populace, economy, and industrialization cause gigantic utilization of common assets to satisfy client needs bringing about contamination of a situation and a reduction in regular assets [2]. Since the most recent decade, corporate organizations are getting inspired by ecological assurance and clients are requesting condition well-disposed items [3]. Organizations attempt to diminish their emanation and asset use to avoid contaminating the earth by dealing with their exercises in their production network [4].

RELATED WORKS

There are distinctive conceivable ways to deal with an exploration plan. These are subjective, quantitative and blended methodology [11-13]. It is important to settle on a decision from the three methodologies recorded above, so as to have an all-around organized research structure and consequently result. So as to do that, maybe the initial step is to realize what establishes every strategy [14-18]. Creswell proposes three system components of

each way to deal with consider while learning quantitative, subjective, or blended methodology [19-21]. These are philosophical suspicions about the general methodology of research called systems of request, and itemized strategy of information gathering, investigation and composing called strategies [22-24]. In the wake of surveying these components of structure, the exploration approach is chosen. Some work in the past decade was explored to conceptualize the KPI, Green and Lean manufacturing theory [25-30]. Thus the proposed study proposes an approach for the qualitative research.

THEORETICAL FRAMEWORK

Sustainability

Supportability has not been a popular thought starting now and into the foreseeable future, since it has been broadly grasped by governments and associations in the course of recent years. Its importance and suggestions have been disputable; anyway it was as yet across the board. The meaning of supportability that is most by and large alluded is from the worldwide association Brundtland Commission, who characterized maintainability as "Addressing the requirements of the present without bargaining the capacity of future ages to address their own issues".

Customarily, condition has been an essential worry in maintainability idea. At the point when people talk about supportability measures, a lot of pressure is included onto condition while the other two measurements go unnoticed a smidgen. Indeed, supportability has three viewpoints. Other than ecological maintainability, financial supportability (monetary improvement) and social manageability (social value) is the two other supportability suggestions. The three parts of supportability are,

- Environmental sustainability needs characteristic capital that is as yet unblemished. This demonstrates the supply and sink elements of the sustainability mustn't be corrupted. In this manner, the extraction of sustainable assets mustn't surpass the rate of restoration, and furthermore the absorptive ability to nature to absorb squanders mustn't be surpassed. Furthermore, the extraction of non-inexhaustible assets should be diminished and may not surpass in concurred least key dimensions.
- Social sustainability necessitates that the attachment of society and its capacity to making sense of towards shared objectives be kept up. Singular wants, similar to those for wellbeing and prosperity, sustenance, sanctuary, training and social articulation should be met.
- Economic sustainability happens when advancement that moves towards social and ecological property is monetarily conceivable.

But while applying the idea of sustainability in manufacturing industries, the companies or the manufacturer should maintain an optimal balance between their employees, profits and other environmental factors. In all business types, the manpower and profit is a key factor to attain a success.

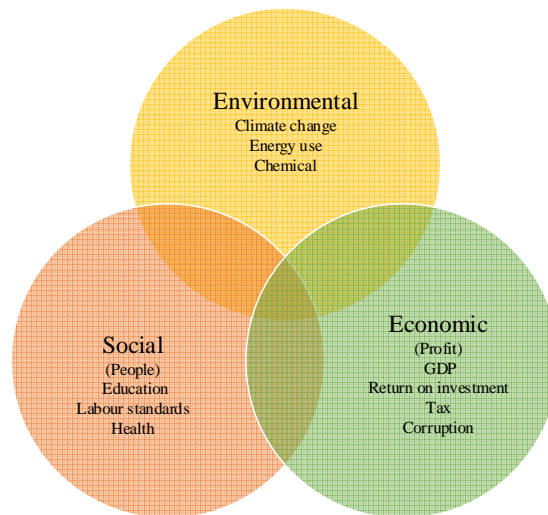


Figure 1: Representation of Sustainability in Three Dimension

Definition of Lean

Lean can be depicted as a philosophical reasoning, which basically centers around taking out waste. In Japanese, muda signifies "squander" and as portrayed, it speaks to any human movement that uses assets yet makes no esteem. Lean reasoning is a power apparatus to counter muda. Womack and Jones portrayed lean reasoning as a way to accomplish more work with less human endeavors, hardware and existence as per what clients truly requires. Lean reasoning gives an example to fulfilled work, enabling prompt criticism on endeavors to change over muda into esteem. "The Toyota Way" portrays eight sorts of squanders as indicated by Toyota which incorporates,



Figure 2: Types of Waste

Principles of LEAN Production

Five standards could be recognized as the fundament of lean generation. The standards can be outlined as the accompanying:

- Specifying esteem from the client's perspective. It is basic to know who the clients are and what the clients' needs to purchase. Clients purchase the final products, not simply the item. For instance, they need to purchase crisp

meat however not a cooler. This plans to implies they purchase the fridge to keep the meat new, however not simply the cooler, since it doesn't bode well if the icebox does not have the capacity which meets the customers" necessity.

- Identifying esteem stream. It is evidential to understand the succession of procedures, the whole distance from crude material to conclusive client, or from item idea to advertise dispatch. As talked about in first guideline, from clients see point, esteem equivalents to anything that the clients are happy to pay for in an ideal item or administration. In this way, the apparatus VSM-esteem spilling mapping (VSM) is created so as to break down or map the procedure for assurance of significant worth included and non-esteem included work.
- Flow. Esteem making steps ought to be created in secured grouping, so the item will stream easily toward the client. One-piece stream is created to make esteem stream.
- Pull. Esteem is pulled by the clients from the following upstream action as the stream is presented in the framework.
- Perfection. Flawlessness alludes to the ideal esteem. As esteem is expounded, esteem streams are distinguished, non-esteem steps are evacuated, and stream and draw are presented, start the procedure again and proceed with it, until a condition of flawlessness is accomplished, in which, immaculate esteem is made with no waste.

From the above dialog, we can say that Lean is an outlook, or state of mind, with a devotion to achieve a without waste activity that is centered around client's needs. It is accomplished by disentangling and ceaselessly improving all procedures and connections in surroundings of trust, regard and full laborer association. It is about individuals, straightforwardness, stream, perceivability, associations and genuine incentive as seen by the client.

Lean Tools and Methods

Lean has a wide assortment of apparatuses and techniques, which help with building up an effective creation framework. In this area, chose devices and techniques which are used by the case organization are introduced as 5S, it very well may be characterized as a framework to lessen squander and streamline efficiency through work environment association and institutionalization did efficiently. The primary point of 5S is to make a proficient, clean and efficient workplace. 5S dependably endeavours to improve administrators and working environment wellbeing, quality and throughput. 5S can be explicitly depicted; Sort (Seiri), Set in Order (Selton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke)

Execution of 5S results in lessen stock, proficient use of work environment, decrease of time for extra parts or instruments, increment control and following techniques, yet 5S additionally make impacts on ecological issues identified with generation, for example, diminish air/water/air spillage, improving machine conditions, diminish mishaps.

Green Manufacturing

In the previous couple of decades' un-went before development in populace, economy, and industrialization makes gigantic utilization of normal assets fulfill client needs bringing about contamination of condition and abatement in regular assets. Since the most recent decade, corporate organizations are getting intrigued by condition assurance and clients are requesting condition well-disposed items. Organizations attempt to lessen their discharge and asset usage to anticipate contaminating condition through dealing with their exercises in their store network.

Green Manufacturing is usually characterized as "disposal of waste by re-characterizing existing generation procedure or framework". This idea does not cutoff points to address just the social and ecological effect of contamination driven procedure, yet in addition process excess, ergonomics and cost suggestions because of wasteful strategies for delivering products. Customary creation estimates quicker and less expensive are never again achievement measures for assembling an item or assessing a current procedure line, yet in addition different achievement factors, for example, materials utilized in assembling, age of waste, effluents and their treatment technique, life of the item lastly, treatment of the item after its helpful life are vital components that are portrayed by green assembling approach as progress factors

Green (ecological) squanders can be characterized as inordinate utilization of assets used or discharged in air, water or land that hurts the human wellbeing or condition. At the point when associations give items or administrations to clients, or clients discard the items causes the making of ecological squanders (EPA).

An Eco Audit can be characterized as an administration device containing a precise, reported, intermittent and target assessment of the execution of the association, the board framework and procedures intended to secure the earth with the point of (1) encouraging administration control of practices, which may have sway on the earth, and (2) evaluating consistence with organization strategies. On a nitty gritty dimension, it tends to be clarified as an incorporated asset use investigation that recognizes chances to decrease natural effect, increment execution and set aside some cash.

Carbon foot printing can be depicted as a marker or device to screen greenhouse gases in assembling forms, carbon outflow through transportation, vitality proficiency and non-renewable energy sources. A carbon impression is the proportion of greenhouse gases (GHGs) created by a given movement, item, business, or store network, communicated in huge amounts of carbon dioxide counterparts (the standard unit for portraying carbon dioxide outflows).

Structure for condition can be depicted as an imaginative methodology, which fabricate associations use to settle on conventional business choices alongside natural effects, thinking about the expense and execution. It is created by Environmental Protection Agency as a deliberate program, which works straightforwardly with the associations so as to adjust ecological and wellbeing contemplations in their business choices into plan and leaving of items and procedures.

An Environmental Management System (EMS) can be basically portrayed as an efficient way to deal with guarantee the administration of ecological exercises in any association. Global Organization of Standardization (ISO) depicts a progressively explicit definition, as that piece of the general administration framework which incorporates authoritative structure, arranging exercises, obligations, rehearses, strategies, procedures and assets for creating, executing, accomplishing, evaluating and keeping up the ecological strategy.

As per International Organization of Standardization (2011), associations are ending up progressively mindful of the requirement for ecological administration, socially capable conduct, and sustainable development and improvement. Proactive administration of natural issues is as a rule straightforwardly identified with big business chance administration, corporate administration, and sound operational and monetary practices and execution. In this manner, International Standards (ISO 14000 arrangement, International Organization of Standards for natural administration) are winding up increasingly more basic to associations to accomplish normal and practically identical ecological administration practices to help the sustainability of their associations, items and administrations.

The advancement of cutting edge innovation prompts the new structures of sustainable waste treatment forms. The Principles of Green Engineering will help organize the advancement of green structuring process, that is adroitly join

from the little decay procedure of particles, materials, item to the general complex frameworks.

The green building techniques are not only a lot of guidelines; rather they resemble set of strategies, which can be received to prevail in execution of sustainable plan process. Advancement of an unsustainable creation line is vital to wipe out the issue that has caused to the coordination, economic and institutional framework. To beat the issues, old procedure ought to be changed to new green one, by reproducing the entire coordination framework. The green standards ought to be executed through and through, so as to get noteworthy impact. The standards can be expressed as pursues,

It isn't economically and earth sound to diminish or restrict the dangerous impacts of innately perilous materials. This must be finished by using abundance measure of capital, material, vitality assets and time. So, to limit use of these capital assets, architects ought to consider structuring items, so that their material data sources and yields ought to be naturally non-dangerous as could reasonably be expected.

Squander age and taking care of identifies with utilization of cash, time and endeavours. Extra speculation can be required for observing and dealing with various kinds of squanders. Squander creation can be maintained a strategic distance from and avoided at whatever point conceivable, the most evident reason for waste age is the aftereffect of defective structure of procedure in organization. Vitality based fuel frameworks; likewise produce squanders bring about greenhouse gases and particulates discharged in air bringing about environmental change. Vitality age frameworks can be intended to anticipate if not decrease the loss alongside treatment endeavours.

Detachment and cleansing are the two strategies, which require additional measure of capital and time. In some creation forms, lethal components are discharged in air. To counter those components, first duty goes ahead fashioners so as to create item plan and propose materials, which are anything but difficult to distinguish.

QUANTIFYING GREEN MANUFACTURABILITY OF A UNIT PRODUCTION PROCESS

Manufacturing is the motor that drives industrialized progression, and sustainability is a standout amongst the most critical ongoing manufacturing contemplations. Specialists and industry consider sustainability of manufacturing forms as a fundamental test economically suitable, protected and solid ways for representatives, networks, and shoppers and which are socially and inventively remunerating for all partners for the short and long haul future.

Green Manufacturing is among the key components that fall under the overall umbrella of sustainability. Green manufacturing manages keeping up natural, economic, and social destinations of sustainability in the manufacturing area. A few instances of sustainable green manufacturing exercises are, lessening unsafe emanations, killing inefficient assets utilization, and reusing. Manufacturing is the significant portion for mechanical vitality utilization, and modern contamination. It is responsible for 84% of vitality related industry CO₂ outflows, and furthermore devours 90% of industry vitality.

Greenness of a Product

An item can be said to be green, as far as one of the three kinds of ecological effects. That is, if ecological effect is

- it has positive contribution to environment,
- lower than conventional products,
- the impact is null,

Constraints of Industry

Producers are very worried about improving the vitality and asset productivity. Nonetheless, adjustment of some vitality effective advances, which are set up utilizing procedures dependent on wrong estimation, can impact or affect generation.

Industry is fearful about specific requirements while assessing the effectiveness improving advances. Other than creation requirements, and innovation limitations, asset (budgetary) imperative is of most extreme significance for the business to execute any vitality effectiveness improving measures.

Unit Manufacturing Process

From frameworks perspective of manufacturing, manufacturing exercises are considered as being made out of numerous dimensions, from an essential dimension (unit process) to that of the whole endeavour, including every one of the exercises in the manufacturing framework. Duflou et al. characterize single machine devices as the littlest unit, of which creation frameworks are made out of. Every unit procedure communicates with other unit forms, and the ecosphere through its limits.

Vitality utilization at the standard unit level in manufacturing forms is commanded primarily by two drivers:

- Cutting time
- Efficiency of process as per torques and cutting force

We considered a unit manufacturing process as the focus of this research, to present initial aspects of a broader framework for green manufacturing.

Green Manufacturing in Grinding Process

Lately, there has been impressive research in green manufacturing in the field of crushing procedures.

Green Aspects in Grinding Process

Among the machining forms, pounding requires astoundingly higher energies to evacuate a particular material volume when contrasted with other regular machining forms like turning, processing and so forth. The principle explanation behind this is, the high measure of scouring and furrowing activities happening in light of vast number of front lines, or rough corn meal. Hashimoto, concentrate the vitality utilization for pounding utilizing diverse chip thicknesses, and for hard turning a similar kind of work pieces, found the grating procedures like granulating result in higher vitality utilization.

Moreover, water-based crushing liquid is generally utilized for oil to improve pounding effectiveness, cooling, and cleaning. Constituents of regular pounding liquid are bases of chlorine, sulfur, and phosphorus, which are destructive, and furthermore cause ecological contamination. Likewise, utilization of pounding liquids results in staggering expenses. For instance, in a few car creation, 15– 30% of the machining costs for a car make is identified with the utilization of granulating liquid. In addition, the conveyance and cleaning of liquids needs high measure of vitality. It has been seen that in specific situations, up to 32% of the all-out vitality utilization of a manufacturing plant has been ascribed to cutting liquids, and it is considerably higher when cooling related helpers, for example, fog gatherers are incorporated. Analysts have chipped away at option (environmentally benevolent) cutting liquid, for instance Winter et al. built up a methodology

which was connected in a granulating case recommending water miscible polymer weakening as better option over non miscible mixable crushing oil. Winter et al. has characterized manufacturing forms as a unit procedure.

We chose crushing as a 'unit manufacturing forms for this examination and underscored on the previously mentioned features of greenness utilizing the unit procedure.

Minimum Quantity Lubrication in Grinding Process

MQL is a method that utilizes a splash of little oil droplets in a packed air fly. The grease is splashed specifically into the cutting zone, as a swap for the colossal streams of regular flood coolant. Since the air fly conveys the oil beads straightforwardly in the cutting region, it gives effective oil. Anyway, exceptional set up and game plans are required when ordinary flood coolant is utilized, so as to enable the liquid to enter the cutting zone productively. Analysts have exhibited MQL as one of the noticeable systems for green manufacturing. For instance, Sadeghi and Haddad, dissected utilizing the test information that in crushing of Ti6Al4V, better pounding execution is given by MQL procedure when contrasted with ordinary grease techniques.

A counterfeit honey bee state calculation falls under the umbrella of swarm astute based calculations. It includes the insight of the searching conduct of swarm of honey bees to discover answers for advancement issues. ABC calculation with its variations has been utilized effectively to take care of different unconstrained numerical enhancement issues. In the examinations, the all-encompassing variant of ABC calculation has demonstrated preferable execution over Particle Swarm Optimization (PSO) and, Differential Evolution (DE).

ABC has discovered tremendous applications in machining space too. For instance Rao and Pawar connected ABC, congruity pursuit, and SA calculations for multi-target enhancement of machining parameters in a granulating procedure. A recreation usage of ABC calculation was utilized in this work to locate the ideal answer for the model produced from the test information.

EXPERIMENTAL WORK

Unit manufacturing process chosen here is surface crushing. Info factors chosen are Depth of cut (DOC), and table speed (Vw) under three distinctive cooling mediums viz-a-viz dry, flood and MQL. Yield factors estimated are unrelated power (Ft), typical power (Fn), and surface harshness (Ra). The estimations of Ft, and Fn are estimated by internet observing framework and surface unpleasantness (Ra) is estimated utilizing Surtonic Surface Profiler after each examination. Workpiece utilized for the experimentation is Titanium composite (Ti6Al4V) that has wide application in air ship manufacturing. Workpiece of measurements, 160 mm × 25 mm × 5 mm is mounted over MS plate estimate, 179 mm × 60 mm × 16 mm, which is then mounted straightforwardly on to the dynamometer with the assistance of screws. MS plate is utilized to evade warm twisting of dynamometer. Aluminium rough granulating wheel with details A46J5V10 is utilized. The crushing powers were estimated with the assistance of KISTLER Piezo-electric dynamometer, type 9257A, and the information is put away, and introduced by utilizing Matlab programming, according to the application necessity. The schematic for pounding power estimating framework is given in Figure 3.

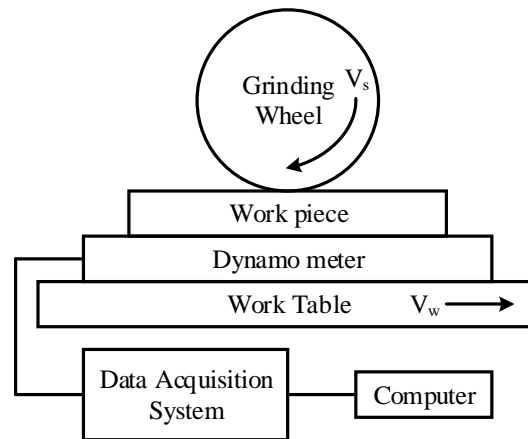


Figure 3: Schematic Diagram of Measure System of Grinding Force

Separate spouts and individual set ups were utilized for flood and MQL strategy for liquid application at instrument work piece interface. Tests were done utilizing an even surface pounding machine produced by Hindustan Machine Tools Ltd., Bangalore, India. As appeared in Figure 4.

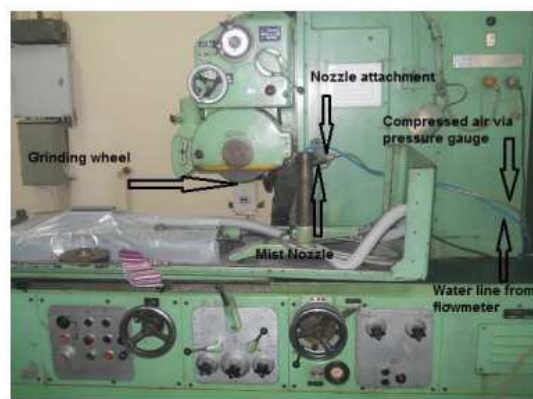


Figure 4: Horizontal Surface Grinder Machine

Full factorial trial plan for all mix of parameters esteems is considered for the present case, with 3 dimensions of profundity of cut, and 3 dimensions of table speed under 3 different ways (dry, flood and MQL) of liquid application. Altogether, there are 27 (3x3x3) arrangements of trials. Cutting conditions chosen for this unit manufacturing process are given in Table I.

Crushing wheel mounting, adjusting, and arrangement, spouts stream rates, dynamometer yield, surface harshness profiler were altogether aligned before beginning the analyses.

Table 1: Cutting Conditions for Unit Manufacturing Process

Parameter	Value
Grinding wheel speed	20 m/s
Depth of cut (DOC)	6 μ m, 10 μ m, and 14 μ m
Table speed (V_m)	5 m/min, 10 m/min, and 15 m/min
Grinding wheel	A46J5V10
Coolant flow rate	4.5 litre/minute
MQL flow rate	80 ml/hr

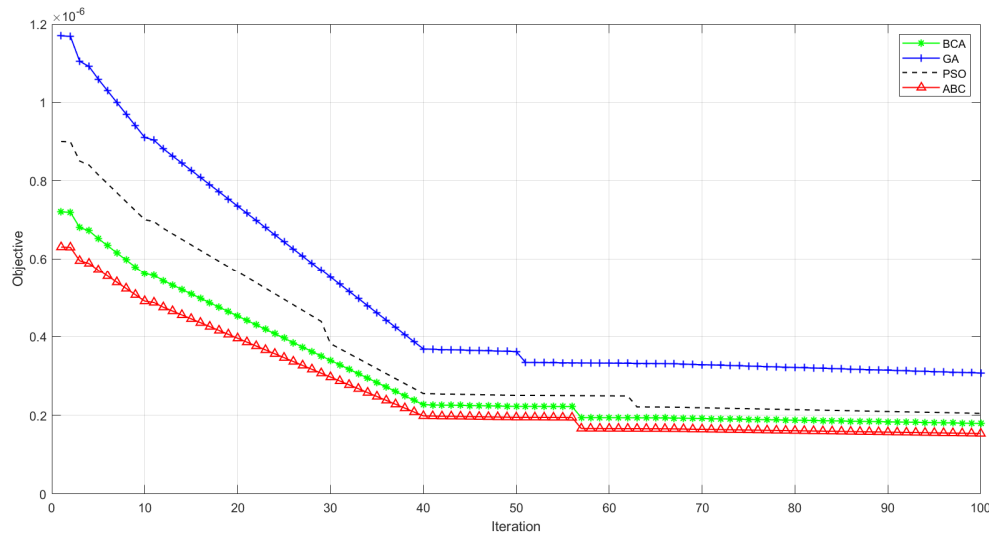


Figure 5: Convergence Chart

In the figure 5, the convergence performance of the various optimization techniques is given. The chart clearly shows that the performance of the proposed ABC based unit production process is better than the other techniques. Hence, it is evident that the proposed technique is better option to optimally maintain environment factor and profit of the manufacturing industry, by implementing green manufacturing.

CONCLUSIONS

The unit production process for the green manufacturing is implemented using artificial bee colony algorithm. The unit production parameters are optimized to maintain the profit and environment factor in optimal level. In the proposed system the data, which influence the green index is optimized to obtain the green manufacturing. The proposed technique is implemented using numerical simulation. The performance of the proposed technique is compared with the conventional techniques such as like Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Bacterial Colony Algorithm (BCA). The performance analysis suggested that the proposed technique provided better performance than these conventional techniques. Ultimately, the proposed technique becomes a better option for the controlling of green manufacturing.

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